CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 8 : Aldehydes, Ketones and Carboxylic Acids (NCERT)

8.1 Structure & Nomenclature

Group	Detail
Aldehyde	–CHO (carbonyl at chain end) ; suffix -al
Ketone	C=O between two carbons ; suffix -one
Carbonyl group	C=O ; carbon is sp^2, planar, polar
Carboxylic acid	–COOH ; suffix -oic acid
Carbonyl polarity	C is δ+ (electrophilic), O is δ−
Reactivity (nucleophilic addition)	Aldehyde > ketone (less steric + more +ve C)

8.2 Preparation of Aldehydes & Ketones

Method	Reaction
Oxidation of alcohols	1° → aldehyde ; 2° → ketone
Ozonolysis of alkenes	Alkene + O_3 → aldehydes/ketones
Rosenmund reduction	Acyl chloride + H_2/Pd-$BaSO_4$ → aldehyde
Stephen reaction	Nitrile + $SnCl_2$/HCl → aldehyde
From nitriles (Grignard)	RCN + R'MgX → ketone (after hydrolysis)
Friedel-Crafts acylation	Benzene + acyl chloride / anhydride → aryl ketone
Gattermann-Koch	Benzene + CO + HCl ($AlCl_3$) → benzaldehyde

8.3 Nucleophilic Addition Reactions

Reaction	Product
With HCN	Cyanohydrin
With $NaHSO_3$	Bisulphite addition product (used in purification)
With alcohol	Hemiacetal → acetal
With ammonia derivatives	Imines / oximes / hydrazones (condensation)
With 2,4-DNP	2,4-dinitrophenylhydrazone (orange-yellow ppt ; test for C=O)
Reduction ($NaBH_4$/$LiAlH_4$)	Alcohol (1° from aldehyde, 2° from ketone)
Clemmensen reduction	C=O → CH_2 (Zn-Hg / HCl)
Wolff-Kishner reduction	C=O → CH_2 (NH_2NH_2 / KOH)

8.4 Oxidation & Special Reactions

Reaction	Detail
Tollens' test	Aldehyde + ammoniacal $AgNO_3$ → silver mirror

Reaction	Detail
Fehling's test	Aldehyde + Fehling's → red-brown Cu_2O ppt
Distinguishing test	Aldehydes give both ; ketones do NOT
Iodoform test	$CH_3CO–$ group (or $CH_3CHOH–$) → yellow CHI_3 ppt
Aldol condensation	α-H aldehyde/ketone + base → β-hydroxy carbonyl
Cannizzaro reaction	Aldehyde with NO α-H + conc. NaOH → alcohol + acid salt
Cross aldol	Two different carbonyls with α-H

8.5 Carboxylic Acids

Concept	Detail
Acidity	Stronger than alcohols/phenols (resonance-stabilised carboxylate)
Effect of −I groups	Electron-withdrawing groups increase acidity (e.g. Cl)
Effect of +I groups	Alkyl groups decrease acidity
Preparation (oxidation)	1° alcohol / aldehyde → carboxylic acid
From nitriles	$RCN + H_2O/H^+ \rightarrow RCOOH$
From Grignard	$R–MgX + CO_2 \rightarrow RCOOH$ (after hydrolysis)
HVZ reaction	α-halogenation of acids (with X_2 / red P)
Decarboxylation	$RCOONa + NaOH\ (CaO) \rightarrow R–H + Na_2CO_3$

8.6 Acidity Comparison & Derivatives

Concept	Detail
Acid strength order	$HCOOH > CH_3COOH$ > other higher acids
Substituent effect	$Cl\text{-}CH_2COOH > CH_3COOH$ (electron withdrawal helps)
Position of halogen	Closer to –COOH → stronger acid
Reaction with $NaHCO_3$	Carboxylic acids give CO_2 (phenols do not) — distinguishing test
Esterification	Acid + alcohol → ester + water (reversible, acid-catalysed)
Acid derivatives	Acid chloride, anhydride, ester, amide (decreasing reactivity)

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Reactivity to nucleophiles	Aldehyde > ketone (less steric hindrance, more +ve carbon).
Tollens/Fehling	Only ALDEHYDES give silver mirror / red Cu_2O. Ketones don't.
Iodoform test	Positive for $CH_3CO–$ group and $CH_3CHOH–$ → yellow CHI_3.
Cannizzaro	Aldehydes with NO α-H disproportionate (one oxidised, one reduced).
Aldol needs α-H	Aldol condensation requires an α-hydrogen ; Cannizzaro requires NONE.
Acidity order	Carboxylic acid > phenol > water > alcohol.

$NaHCO_3$ test	Acids release CO_2 with $NaHCO_3$; phenols do not — key distinction.
Reductions	Clemmensen (Zn-Hg/HCl) & Wolff-Kishner (NH_2NH_2/KOH): C=O → CH_2.